Applying UDL Principles in an Inclusive Design Project Based on MOOCs Reviews

Book Section

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Recommender Systems and MOOCs

While Massive Open Online Courses (MOOCs) may be attracting a wide range of learners, there is a need to provide access to learners that have varying needs (Iniesto, McAndrew, Minocha, & Coughlan, 2017). As learners may have likes and dislikes regarding course designs, there is a need to organize feedback from such a wide range of participants into a coherent and actionable structure. Selection of courses to enroll in among many electives is one of the most influential decisions learners have to make in their educational life. These courses may result in a different career path or educational benefits. Although this selection may be thought to be trivial, the ambiguity of the factors to be considered leads learners to miss chances or make wrong decisions.

The need to reduce the massive amount of information that a user must process to find something of interest on the Internet has influenced the emergence of recommender systems (Adomavicius & Tuzhilin, 2005). Recommender systems are a step forward in the recovery of traditional information and provision of a set of recommendations of interest to the user that match users' expectations (Abhishek, Kulkarni, Kumar, Archana, & Kumar, 2011). Recommendations have significant dependencies between the user and the activity that are centered on the result. For instance, if someone is interested in moving forward professionally, it is more likely that the person will register in an educational program that fits the objectives of the future professional role he/she wants to play.

Adjusting learning based on learners' particular needs has been a priority for educators for years, and artificial intelligence (AI) allows a level of differentiation between learners in different online environments. AI techniques may be useful for several reasons, including their ability to develop and imitate human reasoning and decision-making processes (learning-teaching model) and to minimize the sources of uncertainty in order to achieve an active learning-teaching context. These abilities ensure both learner and system improvement over the lifelong learning mechanism (Colchester, Hagras, Alghazzawi, & Aldabbag, 2017). The idea of customizing curriculum for every learner's needs is not yet viable today, but it will be for AI-powered machines. It is expected that AI in US education will grow by 47.5% from 2017-2021, according to the *AI Market in the US Education Sector* report (Education Artificial Intelligence Market Report, 2018).

Recommender systems, applied in many domains, have recently been used in the educational context (Lu et al., 2015) by advising learners to enroll in specific courses depending on learners' performance in previous courses, their grades, and similarity of content. Drachsler, Verbert, Santos, and Manouselis (2015) found that all recommender systems reviewed aimed to support educational stakeholders by personalizing the learning process, and that previous learner feedback was a critical factor in making appropriate recommendations.

MOOCs are courses delivered through specific eLearning platforms available through the Internet. Literature on MOOCs show cases of adaptive intervention utilizing real-time clickstream data tracking of learners' behaviors and dynamic adaptations of content (Pardos, Tang, Davis, & Le, 2017) and the use of collaborative filtering to extract learner-specific

latent interest from historical access behaviors to provide recommendations (Jing & Tang, 2017). The recommendations can be applied to particular parts of the MOOCs, such as forums where discussions can be difficult to track (Mi & Faltings, 2017), or use external sources like opinions in social media (Wang, Maruyama, Yasui, Kawai, and Akiyama, 2017). The curriculum recommendation mechanism has not gone unnoticed by the big MOOC providers, including *edX* and *Coursera*, for whom trying to offer courses of interest for their learners is a priority in their sustainable development and business model (Tan & Wu, 2018).

Due to the high amount of MOOC offerings around the world, over 800 universities have launched at least one MOOC, the total number of MOOCs that have been announced stands at 9,400 in 2017 (Shah, 2018), and the need for specific recommender sites is indisputable. *YourMOOC4all* is a recommender system influenced by other systems that use learners' feedback. It is similar to other MOOC aggregator sites, such as *Class Central*, *MOOC Lis*t, and *CourseTalk*, where learners can add feedback about the MOOCs they are participating in and receive recommendations. YourMOOC4all also supports review of various pedagogical aspects of the MOOCs through ratings, free text comments, and posted opinions about the content of the MOOC, the provider, or the instructor.

MOOCs and Inclusive Design

There is a critical point ignored in prior MOOC recommender systems in regards to the area of inclusive design - the lack of detailed information regarding accessibility to ensure learners with disabilities can access the eLearning platform and the content. In the development of YourMOOC4all, the goals are to provide information to MOOC providers to integrate accessibility features into the courses and platforms and to inform the learners who are in search of relevant and accessible MOOCs. The project is grounded in the premise that learners' experiences on eLearning platforms offer useful information for others to use to fulfill their interests and to inform special needs regarding accessibility. For instance, if a platform is especially accessible for learners with a visual impairment, that information is of great interest to another learner in a similar situation.

UDL in the MOOC Context

Universal Design for Learning (UDL) offers a framework to evaluate MOOCs design and determine improvements at their early stage of development. This framework considers how to design learning environments to develop expert learners, defined in this framework as resourceful, strategic and motivated (CAST, 2017). UDL is comprised of three design principles, which contain 31 checkpoints. The three design principles are *multiple means of engagement*, *multiple means of representation*, and *multiple means of action and expression*. These outline the overall goal while the checkpoints provide specific design advice that considers accessibility and learning. In the most recent version of the UDL Guidelines (CAST, 2018), the checkpoints have been further organized into *access*, *build*, and *internalize* categories.

To take a closer look at the checkpoints and their relationship with accessibility, the *multiple means of representation* principle is explored in depth. In the context of MOOCs, the checkpoint "to offer alternatives for visual information" (1.3) is categorized as *access*, providing options for perception (CAST, 2018). This focus on access is reflected by accessibility standards, such as the Web Content Accessibility Guidelines ([WCAG 2.1] W3C Web Accessibility Initiative, 2018) in guideline 1.1 which also recommends alternative

text for non-text material. Specifically, UDL checkpoint 1.3 includes the suggestion to use alternative text when there is an image as an option for perception. While the alternative text of an image provides access to support learning, it is also crucial to building on that access.

For example, if a MOOC uses images to illustrate two examples of amphibians with depictions of a salamander and a frog, the alternative text is likely to include the words *frog* and *salamander*. A learner may be unfamiliar with the word *salamander,* which would make the term a potential candidate for a glossary item. Checkpoint "clarify vocabulary and symbols" (2.1) is as an example of providing options for language and symbols, suggesting the design should clarify vocabulary (CAST, 2018). Checkpoint 2.1 is supported by research that indicates providing glossaries in the text is linked with vocabulary gains for language learners and struggling readers (Proctor, Dalton, and Grisham, 2007).

UDL guidelines suggest that to help *internalize* information about amphibians, checkpoint "highlight patterns, critical features, big ideas, and relationships" (3.2) outlines the design should potentiate ways to provide options for comprehension (CAST, 2018). For images of the frog and the salamander, one image might highlight the critical feature that a frog has no tail placing it in the order *Anura*, while the salamander image would have a visible tail placing it in the order *Urodela*. The images of the frog and salamander may also illustrate that both Anura and Urodela are orders within the species of amphibians to highlight this relationship. Using the UDL Guidelines, one can look at a MOOC about amphibians and ask -

- Do the images of the frog and salamander have alternative text?
- Is there a glossary of terms?
- Do the images highlight key features and relationships?

The design would then support access to learning materials that provided answers to those questions, building on the access to learn and internalizing the key features and relationships. While this example illustrates how the UDL guidelines might inform the creation of images that teach about amphibians, there are parallels to how learners might consider concepts within a MOOC and how one course might relate to other courses.

There is evidence that when interacting with an online course, like a MOOC, concept mapping the course can lead to better learning outcomes (Huang et al., 2012). It illustrates the parallel nature of how concept maps can be used in instructional design and how internalizing this approach when evaluating a MOOC can produce improved learning outcomes. YourMOOC4all is a project that offers these options.

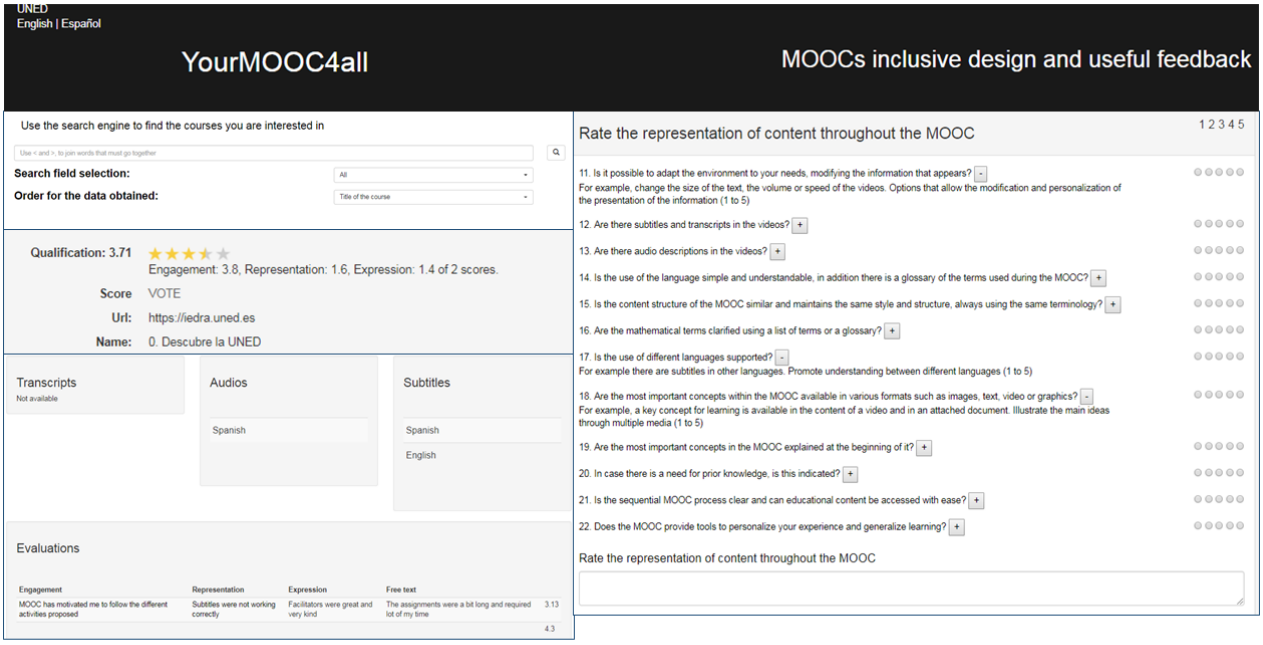
YourMOOC4all: An Inclusive Design Project

YourMOOC4all is designed with the objective of developing expert learners. If learners are developed as experts, they may be considering both the MOOC elements as well as the relationships between MOOCs. To be successful, expert learners need to be able to recognize the tools and resources that help them to learn (strategic), organize tools and resources to facilitate their learning (resourceful) and evaluate the design of MOOCs they take (motivate) (CAST, 2017). The YourMOOC4all project has designed a MOOC aggregator site with the following aims:

1. Provide information to MOOC developers and recommendations to learners seeking accessible MOOCs.

2. Support learner evaluation of inclusive instructional design aspects of MOOCs using the UDL framework and retrieve recommendations, helping learners to locate MOOCs that fit their needs.

At this time, the project is a programmed prototype hosting more than 700 MOOCs for testing (Iniesto & Rodrigo, 2018). The website is multi-language and enables learners to search by free text, enabling them to refine the search by course title, theme or related course information. It is possible to order the results by title, institution, platform, and average score obtained in previous evaluations. Some of the YourMOOC4all main features can be seen in Figure 1 (note the search engine and MOOC available information on the left and the rating system for the means of representation on the right).



(Figure 1) YourMOOC4all Features

The dynamically captured course information includes general information about the MOOC such as name, platform and provider institution, thematic information, learning objectives, expected prior knowledge, recipients and required level to participate, and accessibility information about the availability of sign language, transcriptions, audio-description and captions.

YourMOOC4all in Practice

An evaluation matrix was created following the UDL framework, with a total of 31 indicators directly related to the checklists (Table 1). These indicators have been developed by the authors based on the UDL guidelines (CAST, 2018) and with the support of a UDL expert. Learners apply this matrix to quantitatively rate any of the optional indicators using a Likert scale. All the indicators offer a small tip to help learners understand each question with an example, as can be observed in Figure 1.

Table 1. YourMOOC4all Evaluation Matrix Indicators distributed by UDL principles and checklist items.

	Multiple means of engagement	Multiple means of representation	Multiple means of action and expression
Access	Provide options for Recruiting Interest • Can you participate whenever you want in the discussions or activities and work without time limits? (7.1) • Did the proposed activities match what you wanted to learn, giving you the possibility to explore the content and be creative? (7.2) • Is the information about the activities notified in advance (at the beginning of the MOOC or with emails), is there access to a calendar with all the information? (7.3)	Provide options for Perception • Is it possible to adapt the environment to your needs, modifying the information that appears? (1.1) • Are there captions and transcripts available in the videos? (1.2) • Are there audio descriptions available in the videos? (1.3)	Provide options for Physical Action • Is there time limit to perform the tests or activities when you start them? (4.1) • Is it possible to move around the MOOC using only the keyboard or the mouse? (4.2)
Build	Provide options for Sustaining Effort & Persistence • Do you have space to formulate what you are expecting to learn at the beginning of the MOOC? (8.1) • Is the level of difficulty in the activities proposed in the MOOC differentiated? (8.2) • Can you discuss what you want to learn in the MOOC with other partners? (8.3) • Are the responses from the facilitators positive and oriented to help you? (8.4)	Provide options for Language & Symbols • Is the use of the language simple and understandable, also, is there a glossary of the terms used during the MOOC? (2.1) • Is the structure of the MOOC similar and maintains the same style, using the same terminology? (2.2) • Are the mathematical terms clarified using a list of terms or a glossary? (2.3) • Is the use of different languages supported? (2.4) • Are the most important concepts within the MOOC available in various formats such as images, text, video or graphics? (2.5)	Provide options for Expression & Communication • Are there social networks or external tools available in the MOOC? (5.1) • Are external links and complementary readings offered in the MOOC? (5.2) • Do the MOOC facilitators help in the process of communication and reflection? (5.3)
Internalize	Provide options for Self-Regulation • Do the tests provide feedback that helps your learning? (9.1) • Is there a space available to talk freely about the difficulties encountered? (9.2) • Is there any help in case you have not been able to participate in the whole MOOC? (9.3)	Provide options for Comprehension • Are the most important concepts in the MOOC explained at the beginning of it? (3.1) • If there is a need for prior knowledge, is this indicated? (3.2) • Is the sequential ordering of tasks in the MOOC logical? (3.3) • Does the MOOC provide tools to personalize your experience and generalize learning? (3.4)	Provide options for Executive Functions • Is it clear at the beginning of each module what is to be learned and the calendar of activities? (6.1) • Are there quizzes during the MOOC to facilitate reflection on what has been learned? (6.2) • Are guides provided to assist in the learning process and the use of the platform? (6.3) • Does the MOOC show the progress you have made? (6.4)

In the evaluation process, learners can answer open-ended questions, enriching the qualitative content of the feedback for MOOC providers and offering valuable information to other learners. The YourMOOC4all design captures quantitative information through the ratings and qualitative information from comments to triangulate the data.

The project and associated development research promotes a better understanding the accessibility barriers MOOCs have and establishes a fluent communication with MOOC providers, providing recommendations to assist them in improving accessibility to reduce the identified barriers in MOOCs. The design of the project records the different runs of a single MOOC. For example, if a *Pedagogical Methodologies* MOOC has three editions, this is reflected and shown in YourMOOC4all, tracking the changes and improvements. Therefore the communication is bidirectional, allowing evaluation of new MOOC runs wherein MOOC designers and instructors have implemented the suggested recommendations.

Table 2. Key Areas for Recommendation and Improvement by Guideline to MOOC Providers.

	Multiple means of engagement	**Multiple means of representation**	**Multiple means of action and expression**
Access	Provide options for Recruiting Interest Indicators to engage learners in discussion and activities, to deliver full access to the content and notify in advance the workload	Provide options for Perception Standardization around the adaptability of the educational environment, production of captions, transcripts and audio descriptions	Provide options for Physical Action Configurations to avoid time limits when performing tests or activities and access through the keyboard
Build	Provide options for Sustaining Effort & Persistence Suggestions to allow learners to formulate goals, identify activities difficulty and allow discussion between peers providing oriented feedback from the facilitator's side	Provide options for Language & Symbols Guidelines to provide consistent and straightforward language, structure, style and terminology, allowing support to different languages and formats	Provide options for Expression & Communication Guidelines to provide use of social networks, external links and complementary readings, and orientations to facilitators to help in the process of communication and reflection
Internalize	Provide options for Self-Regulation Indicators to provide non-academic discussion spaces and help when unable to participate in the MOOC	Provide options for Comprehension Orientation on explicit prior knowledge, concepts and sequential ordering of task from the beginning of the MOOC	Provide options for Executive Functions Indications on a calendar of activities, progress made, provision of quizzes to facilitate reflection and guidelines to help the learning process

Table 2 indicates the key areas at guideline level where recommendation and improvement feedback is expected to be delivered to MOOC providers. If followed, these recommendations for integrating UDL into a MOOC could prove to significantly extend

access and understanding of course content through diversified design features. This is a temporary table since the input provided by learners will determine which key areas to improve in the learning design. In that sense, the open-ended questions answered by learners will have an impact on MOOC providers, since they may offer new ideas and perspectives that could be related to the UDL framework, current MOOC development processes, and beyond.

Conclusions and Future Work

YourMOOC4all is designed to develop expert learners through the application of UDL principles to crowd-sourced MOOC design evaluation. It supports learners internalizing UDL guidelines and offers a structure to MOOC providers to compare their design quality processes. Future work includes adding user profiling options to the search (for example, language preferences or existence of captions) and increasing the sample of MOOC providers.

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